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(54) Dialysis solution for extracorporeal hemodialysis

Dialyselösung zur extrakorporalen Hemodialyse

Solution dialytique destinée à l'hémodialyse extracorporale

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- **NEUROSCIENCES, vol. 15, 1989 pages 371-376, A. MORI ET AL. 'A new hydroxyl radical scavenger: EPC-K1'**
- **BIOCHEM. PHARMACOL., vol. 44, no. 6, 1992 pages 1193-1199, N. VERMEULEN ET AL. 'The role of lipid peroxidation in the nephrotoxicity of cisplatin'**
- **AM. J. KIDNEY DIS., vol. 18, no. 1, July 1991 pages 84-90, G.M. SHAH ET AL. 'Ascorbic acid supplements in patients receiving chronic peritoneal Dialysis'**
- **ACTA MED. OKAYAMA, vol. 47, no. 2, April 1993 pages 121-127, K. TANEMOTO ET AL. 'Beneficial effects of EPC-K1 on the survival of warm ischemic damaged graft in rat cardiac transplantation'**

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Description

1. Field of the Invention

This invention relates to the use of an ascorbyl tocopheryl diester of phosphoric acid or a pharmacologically acceptable salt thereof, for the manufacture of a dialysis solution for extracorporeal hemodialysis.

2. Description of the Prior Art.

It is known that the active oxygen species and free radicals formed in the body may cause aging and a broad spectrum of diseases inclusive of malignant neoplasms. The kidney, in particular, is highly relevant to such active oxygen species and free radicals because of the vital physiological functions assigned to this organ.

EP-A-0 324 387 and EP-A-0 430 045 disclose that ascorbic acid tocopheryl phosphate diesters are suitable for inhibition of Maillard's reaction in the human body;

EP-A-0 409 999 discloses a liquid preparation for intraocular perfusion, in particular an intraocular irrigating solution which reduces risks for damage to intraocular tissues, which is used when, in the field of surgical treatment of ophthalmic diseases, the site of operation is inside the eyeball;

Neurosciences Vol. 15, pp. 371-376 (1989) discloses a new hydroxyl radical Scavenger: EPC-K_1; and

Biochemical Pharmacology Vol. 44, No. 6 pp. 1193-1199, 1992 discloses the role of lipid peroxidation in the nephrotoxicity of cisplatin.

Meanwhile, chronic hemodialysis induces dialysis amyloidosis in the patient on dialysis treatment. As a therapeutic approach, the use of a high-performance dialysis membrane is gaining popularity for eliminating β_2-microglobulin (β_2-MG) which is a causative agent of amyloidosis. However, when this dialysis treatment is performed chronically, symptomatic aggravations are sometimes experienced despite improvements in the β_2-MG picture and it has been pointed out that free radicals are involved in the onset of dialysis amyloidosis as well. However, it is the state of the art that there is not known a dialysis solution for extracorporeal hemodialysis which is effective for the prevention and treatment of amyloidosis.

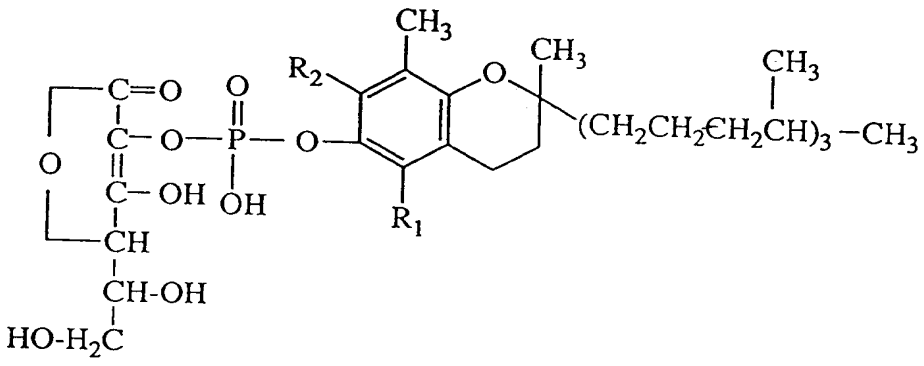
Under the circumstances, a real demand exists in the art for a hemodialysis solution which would successfully inhibit the formation of, or scavenge, free radicals in vivo and, as such, be useful for the prophylaxis and therapy of dialysis amyloidosis.

The inventors of this invention long studying the pharmacological actions of ascorbyl tocopheryl diester of phosphoric acid discovered that this compound effectively inhibits the formation of free radicals in the body and scavenges them and is of value as a dialysis solution for extracorporeal hemodialysis. This invention has been developed on the basis of the above findings.

SUMMARY OF THE INVENTION

This invention is, therefore, directed to:

(1) the use of a phosphoric acid diester of the following formula:



(wherein R_1 and R_2 are the same or different and each represents a hydrogen atom or a methyl group) or a pharmacologically acceptable salt thereof (hereinafter referred to collectively as the compound of this invention), for the

manufacture of a dialysis solution for extracorporeal hemodialysis;

(2) the dialysis solution for extracorporeal hemodialysis as defined under (1) which comprises said phosphoric acid diester or pharmacologically acceptable salt in a concentration of 0.001 to 0.05 (w/v)%; and

(3) the dialysis solution for extracorporeal hemodialysis as defined under (1) or (2) which has an osmotic pressure of 270 to 300 mOsm/kgH_2O and a pH value of 6 to 8.

DETAILED DESCRIPTION OF THE INVENTION

The compound for use in the dialysis solution for extracorporeal hemodialysis in accordance with this invention can be synthesized by the process desribed in the specification of Japanese Patent Publication H-2-44478 (corresponding to EP Publication 0 127 471) or in the specification of Japanese Patent Application Kokai S-62-205091 (corresponding to EP Publication 0 236 120), or any process analogous therewith, among others.

It is already known that the compound of this invention for use in the dialysis solution for extracorporeal hemodialysis is of use as an anticataract agent, a prophylactic and therapeutic agent for climacteric disturbance, a skin care cosmetic ingredient (Japanese Patent Publication H-2-44478) an antiinflammatory agent (Japanese Patent Publication H-1-27044) an antiulcer agent (Japanese Patent application Kokai S-63-270626 (corresponding to EP Publication 0 288 969), and a prophylactic and therapeutic agent for ischemic organic disorders (Japanese Patent Application Kokai H-2-111722 (corresponding to EP Publication 0 324 387) among others.

The compound of this invention for use in the dialysis solution for extracorporeal hemodialysis can be used in whichever of the free form and in the form of a pharmacologically acceptable salt thereof. The pharmacologically acceptable salt that can be used includes salts with alkali metals such as sodium, potassium, etc. and salts with alkaline earth metals such as calcium and magnesium, among others. Other types of salts, if acceptable from pharmacologic points of view, can also be employed.

The dialysis solution for extracorporeal hemodialysis according to this invention may contain one or more species of the compound of this invention according to the intended use.

The compound of this invention for use as the active ingredient of said dialysis solution is extremely low in toxicity and highly safe and, therefore, can be used advantageously for purposes of this invention [e.g. the LD_{50} values of L-ascorbyl DL-α -tocopheryl phosphate potassium (hereinafter referred to briefly as EPC-K) $\geqq$ 5 g/kg p.o. (rats) and $\geqq$ 100 mg/kg i.v. (rats)].

The dialysis solution for extracorporeal hemodialysis according to this invention is manufactured in the form of a suitable solution by the per se known procedure. The osmotic pressure and pH of the liquid preparation are preferably adjusted within the respective ranges for hemodialysis solutions in general. For example, the osmotic pressure is about 270 to 300 mOsm/KgH_2O, preferably about 280 to 290 mOsm/kgH_2O, and the preferred pH is about 6 to 8. Such a liquid preparation may contain a variety of other ingredients which are generally included in dialysis solutions for extracorporeal hemodialysis, for example various salts such as sodium chloride, potassium chloride, calcium chloride, magnesium chloride, sodium acetate, sodium hydrogen carbonate, etc. and saccharides such as glucose in the usual amounts. If necessary, the dialysis solution may be supplied in a solid dosage form, e.g. tablet, granule, powder, etc, for extemporaneous reconstitution.

The artificial kidney dialysis solution thus manufactured in accordance with this invention can be applied to dialysis treatment using a conventional extracorporeal hemodialyzer of the hollow fiber (HFK), kiil (plate) or coil type. Each of such dialyzers dialysate comprises a blood compartment and a dialysate compartment as partitioned by a semipermeable membrane (dialysis membrane) of e.g. cellulose or polymethyl - methacrylate (PMMA), which are communicating with a blood line and a dialysate line, respectively, in a loop. The desired dialysis treatment can be accomplished by allowing the substances to be removed from the blood to migrate into the dialysis solution across the dialysis membrane.

The concentration of the compound of this invention in the dialysis solution for extracorporeal hemodialysis is dependent on species of the compound, dialysis time, the patient's age and body weight, the symptoms to be controlled, and other conditions. Generally, a concentration of about 0.001 to 0.05 (w/v) % or preferably about 0.005 to 0.02 (w/v)% is recommended.

Unless contrary to the objects of this invention, the dialysis solution of this invention may contain other therapeutic agents for renal disorder and/or agents expected to produce other pharmacological effects.

EXAMPLES

The following experimental example and formulation example are further illustrative of this invention.

[Experimental Example 1] Chemiluminescence assay of the scavenging effect of the drug on the neutrophil-derived active oxygens formed due to the dialysis membrane

The scavenging effect of the compound of this invention on the neutrophil-derived active oxygens formed due to the dialysis membrane was evaluated by the chemiluminescence assay.

Test compound: EPC-K
Material:

Dialysis Membrane	Artificial kidney(for clinical use)	Membrane material	Manufacturer
	Filtrizer (B2-1, 5H)	Polymethyl methacrylate	Toray Industries, Inc.

Test substance: EPC-K
Instrument:

Photon counter	Distributor
Lumat(registered Trademark) (LB 9501)	Berthold

Methods:

1. Preparation of a neutrophil suspension

An SD rat was intraperitoneally infused with 120 ml/kg of 1% casein-containing Krebs-Ringer bicarbonate buffer (Ca^{2+}-free) and kept as it was for 15 to 18 hours. Then, ice-cooled phosphate buffered saline (ca^{2+}/Mg^{2+}-free, briefly PBS) was infused into the peritoneal cavity and after massaging the abdomen, laparotomy was performed to collect the peritoneal fluid. This fluid was centrifuged (4°C) at 150G for 5 minutes and the sediment was subjected to hemolysis treatment, washed with 2 portions of PBS and suspended in Hanks buffered saline (Ca^{2+}/Mg^{2+}-free; abbreviation: HBS) at a concentration of 5×10^6 cells/ml.

2. Preparation of a membrane material suspension (a suspension of PMMA)

The hollow fiber of polymethyl methacrylate (PMMA) was taken out from the Filtrizer cartridge, rinsed and dried. The dried hollow fiber was milled in a mortar (to a particle diameter of about 20 to 100 μm) and suspended in HBS at a concentration of 100 mg/ml.

3. Preparation of a luminescence reagent (a solution of MCLA)

MCLA (2-methyl-6-[p-methoxyphenyl]-3,7, - dihydroimidasolo[1,2-a]pyrazin-3-one)(Cypridina luciferin analog; manufactured by Tokyo Kasei Kogyo Co., Ltd.) was dissolved in HBS at a concentration of 5 μM.

4. Effect of the test substance, 1 μM, 3 μM or 10 μM, on the chemiluminescence due to neutrophil-derived active oxygens

EPC-K was dissolved in HBS at final concentrations of 1 μM to 10 μM. To 100 μl of each solution were added 300 μl of the neutrophil suspension and 100 μl of the MCLA solution and the mixture was incubated at 37°C for 10 minutes. Then, 20 μl of the PMMA suspension was added and the resulting MCLA-dependent chemiluminescence was quantitated in 5 replicates. From the photon count at maximal emission was subtracted the minimal count immediately following addition of the PMMA suspension to arrive at the chemiluminescence photon count (CPM). The count obtained with HBS (blank test) was compared with the count obtained with the drug and the percent inhibition (%) was calculated by means of the following equation.

$$\text{Percent inhibition}(\%) = \frac{\text{Count for blank - Count for drug}}{\text{Count for blank}} \times 100$$

Results: The results are shown in Table 1.

Table 1

Effect of the compound of this invention on neutrophil-derived active oxygens formed due to the dialysis membrane			
Drug	Concentration	Chemiluminescence photon count (CPM)	Percent inhibition(%)
EPC-K	10 μ M	145181± 3648	65.8
	3 μ M	26800± 3057	36.8
	1 μ M	32230± 6949	24.0
Blank test	-	42392± 12789	-
Each value is the mean ± standard deviation. The number of cases is 5 per group.			

It is apparent from Table 1 that the compound of this invention effectively inhibits the neutrophil-derived active oxygens formed due to the dialysis membrane and is, therefore, of use as a dialysis solution for extracorporeal hemodialysis.

[Formulation Example 1] Dialysis solution for extracorporeal hemodialysis

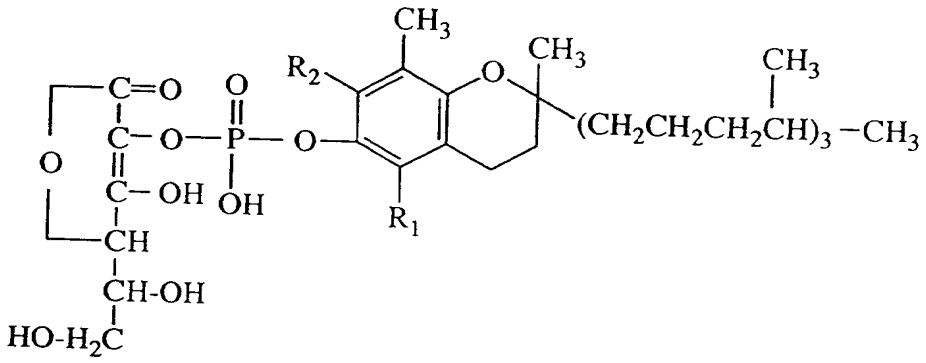
EPC-K	0.05 g
Sodium chloride	4.0 g
Potassium chloride	0.11 g
Calcium chloride (dihydrate)	0.13 g
Magnesium chloride (hexahydrate)	0.11 g
Sodium citrate (trihydrate)	1.0 g
Sodium acetate	2.0 g
Glucose	1.4 g
0.1 N-Sodium hydroxide	q.s.
Distilled water	To make 100 ml
	pH 7.2

Using the above components, a dialysis solution for extracorporeal hemodialysis is manufactured in the per se conventional manner. This solution is extemporaneously diluted 7-fold.

The composition of this invention is also of use as a dialysis solution for extracorporeal hemodialysis with the prophylactic/therapeutic effect on dialysis amyloidosis.

Claims

1. Use of a phosphoric acid diester of the following formula:



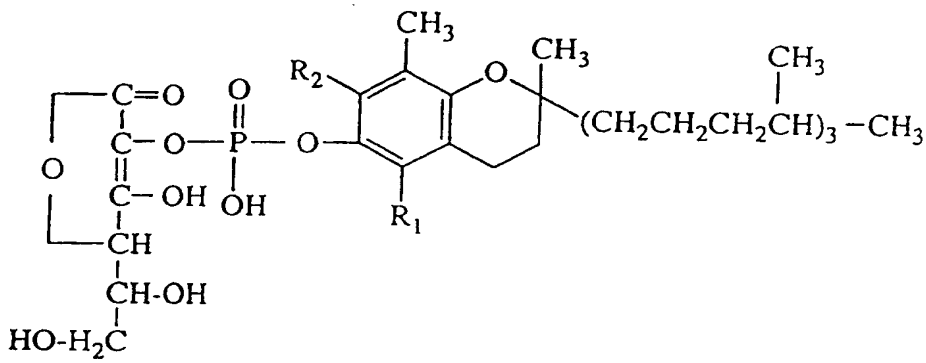
(wherein R_1 and R_2 are the same or different and each represents a hydrogen atom or a methyl group) or a pharmacologically acceptable salt thereof, for the manufacture of a dialysis solution for extracorporeal hemodialysis.

2. The use of claim 1 wherein the dialysis solution for extracorporeal hemodialysis comprises said phosphoric acid diester or pharmacologically acceptable salt in a concentration of 0.001 to 0.05 (w/v)%.

3. The use of claims 1 or 2 wherein the dialysis solution for extracorporeal hemodialysis has an osmotic pressure of 270 to 300 mOsm/kgH_2O and a pH value of 6 to 8.

Patentansprüche

1. Verwendung eines Phosphorsäurediesters der folgenden Formel



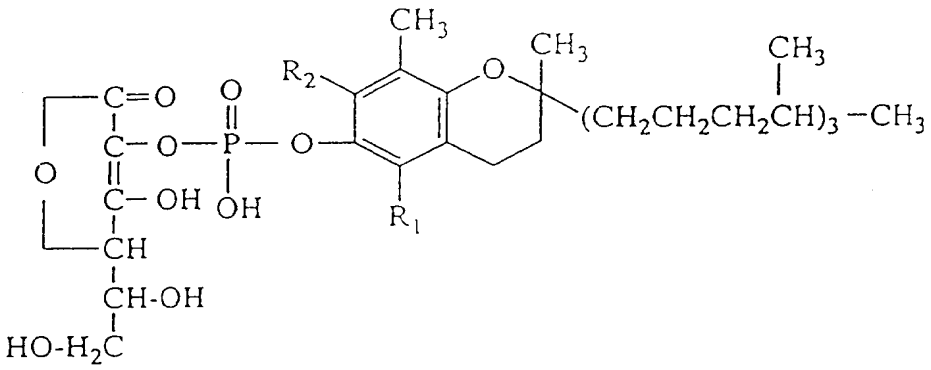
(wobei R_1 und R_2 gleich oder verschieden sind und jeweils ein Wasserstoffatom oder eine Methylgruppe darstellen) oder eines pharmakologisch annehmbaren Salzes davon zur Herstellung einer Dialyselösung für die extrakorporale Blutdialyse.

2. Verwendung gemäß Anspruch 1, wobei die Dialyselösung für die extrakorporale Blutdialyse den phosphorsäurediester oder das pharmakologisch annehmbare Salz davon in einer Konzentration von 0,001 bis 0,05% (w/v) umfaßt.

3. Verwendung gemäß Anspruch 1 oder 2, wobei die Dialyselösung für die extrakorporale Blutdialyse einen osmotischen Druck von 270 bis 300 mOsm/kg H_2O und einen pH-Wert von 6 bis 8 hat.

Revendications

1. Utilisation d'un diester d'acide phosphorique ayant la formule suivante:



(dans laquelle R_1 et R_2 sont identiques ou différents et représentent chacun un atome d'hydrogène ou un groupe méthyle), ou d'un de ses sels pharmacologiquement acceptables, pour la préparation d'une solution de dialyse pour l'hémodialyse extracorporelle.

2. Utilisation selon la revendication 1 dans laquelle la solution de dialyse pour l'hémodialyse extracorporelle comprend ledit diester d'acide phosphorique ou un de ses sels pharmacologiquement acceptables en une concentration de 0,001 à 0,05 (p/v) %.

3. Utilisation selon la revendication 1 ou 2 dans laquelle la solution de dialyse pour l'hémodialyse extracorporelle a une pression osmotique de 270 à 300 mOsm/kg d'H_2O et une valeur de pH de 6 à 8.